California's Surface Water Ambient Monitoring Program (SWAMP)

Freshwater Harmful Algal Blooms (HABs) in California and SWAMP's Statewide Assessment and Support Strategy

For assistance in accessing this document please send an email to EPACyanoHABs@epa.gov

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California Water Boards

SWAMP Surface Water Ambient Monitoring Program

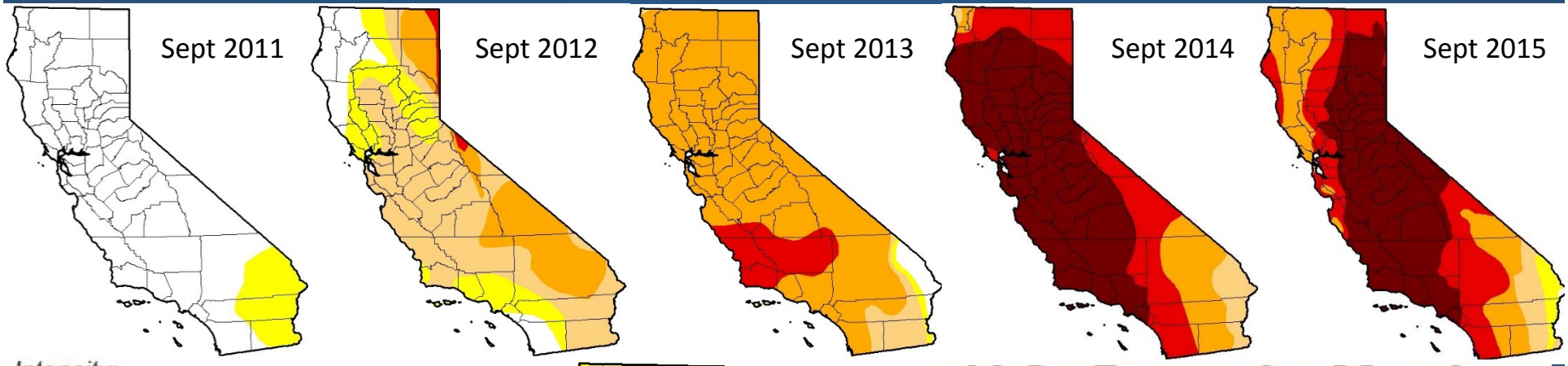
Freshwater Toxins Record Breaking Years 2014 – 2016

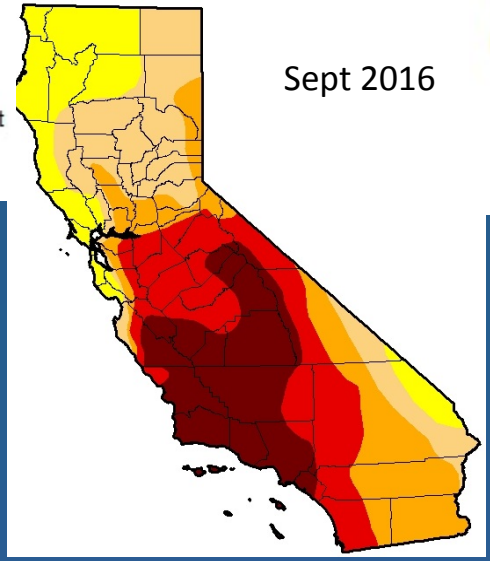
- First time health advisories and closures for many lakes
- Extremely high toxin concentrations recorded
- Dog deaths attributed to toxins
- Multiple toxins detected simultaneously

Freshwater Toxins Record Breaking Years 2017

- First time health advisories and closures for many lakes
- Extremely high toxin concentrations recorded
- Dog deaths attributed to toxins
- Multiple toxins detected simultaneously
- Already seeing blooms in 2017

Record-Breaking Drought





U.S. Drought Monitor

California

CLIMATE

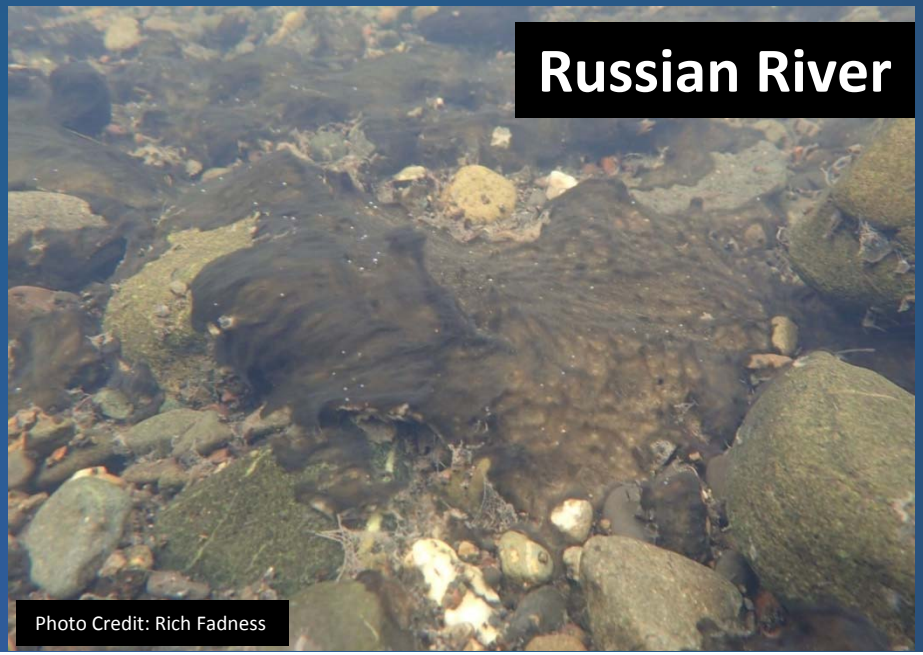
Blooms Like It Hot

Hans W. Paerl[1] and Jef Huisman[2]

A link exists between global warming and the worldwide proliferation of harmful cyanobacterial blooms.

Paerl et al. 2009

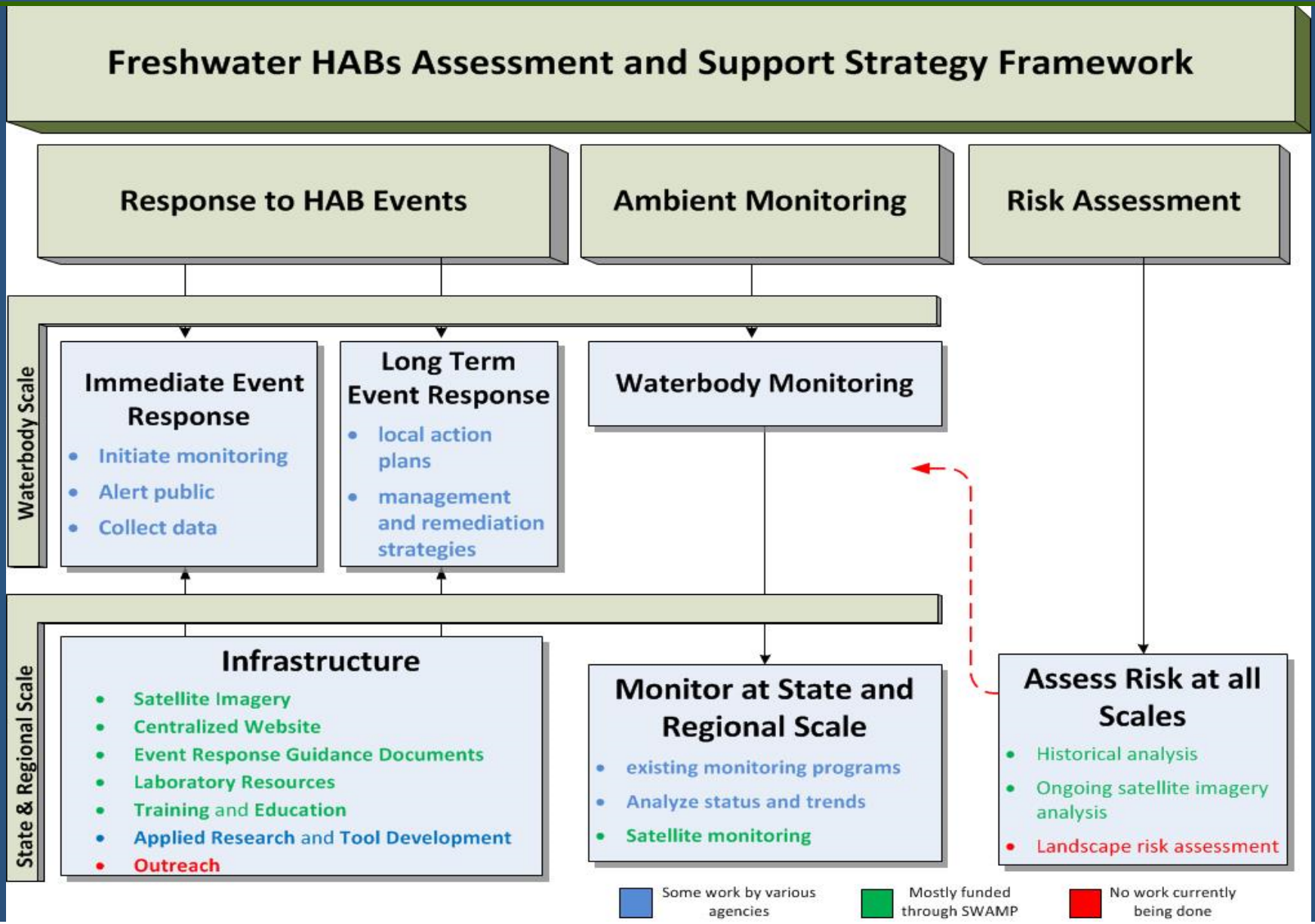
Planktonic and Benthic HABs



Early Challenges

- Unprepared to investigate blooms reports and dog deaths
  - Lack of staff training & response materials
  - Unsure who key contacts are for counties, cities, water body managers
  - Public Health officials hesitant to respond without clear guidance
- Lack of consistent message in response to media calls
- Lack of communication with the public about HABs

California Strategy



California Strategy

- Centralized Portal for Bloom Reporting & Information Dissemination
- Event Response Guidance
- Standard Operating Procedures for Monitoring & Sampling
- Laboratory Resources
- Education & Outreach
- Satellite Imagery for Early Bloom Detection
- Build Partnerships (CA CyanoHAB Network)

SWAMP
Surface Water Ambient Monitoring Program

California Freshwater Harmful Algal Blooms Assessment and Support Strategy

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SWAMP-SP-SB-2016-0001

January 2016

http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/SWAMP/HABstrategy_phase%201.pdf

Water Boards

www.waterboards.ca.gov/swamp

California Strategy

Centralized Website for Bloom Reporting and Information Dissemination

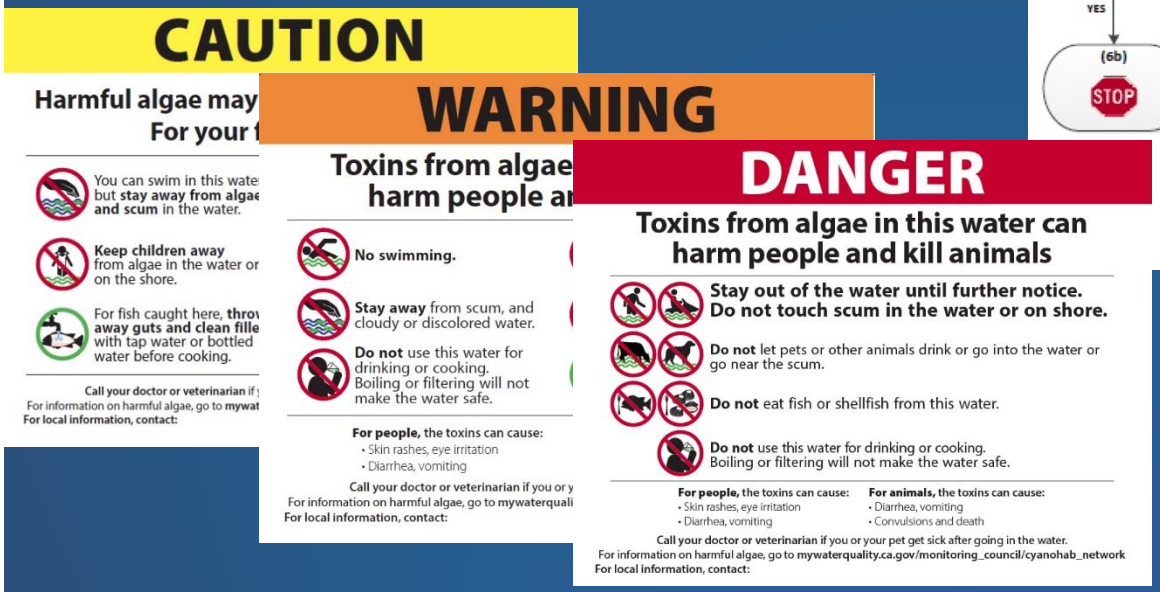
http://mywaterquality.ca.gov/habs/index.html

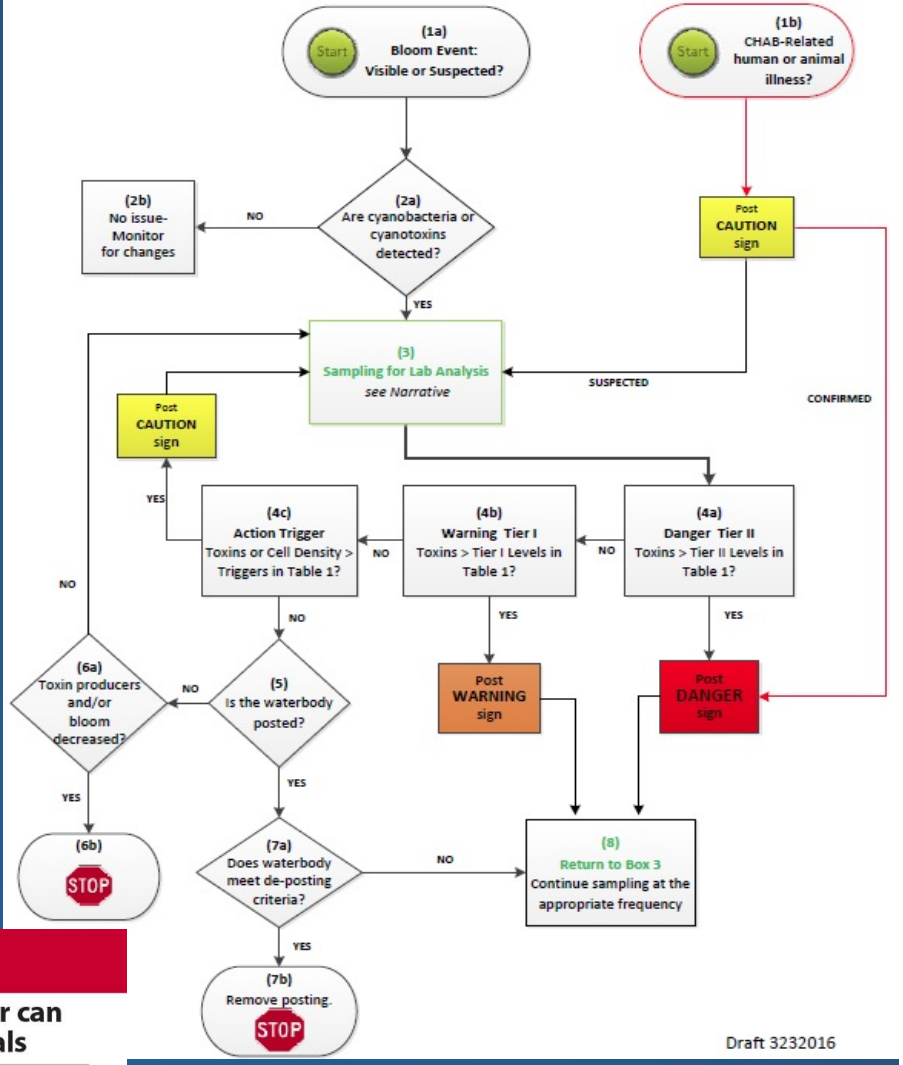
Event Response Guidance

Table 1. CyanoHAB Trigger Levels for Human Health

	Caution Action Trigger	Warning TIER I	Danger TIER II
Primary Triggers [a]			
Total Microcystins [b]	0.8 µg/L	6 µg/L	20 µg/L
Anatoxin-a	Detection [c]	20 µg/L	90 µg/L
Cylindrospermopsin	1 µg/L	4 µg/L	17 µg/L
Secondary Triggers			
Cell Density *(Toxin Producers)*	4,000 cells/mL	--	--
Site Specific Indicators of Cyanobacteria	Blooms, scums, mats, ect.	--	--

[a] The primary triggers are met when ANY toxin exceeds criteria.
[b] Microcystins refers to the sum of all measured microcystin variants. (See Box 3)
[c] Must use an analytical method that detects ≤ 1µg/L Anatoxin-a.





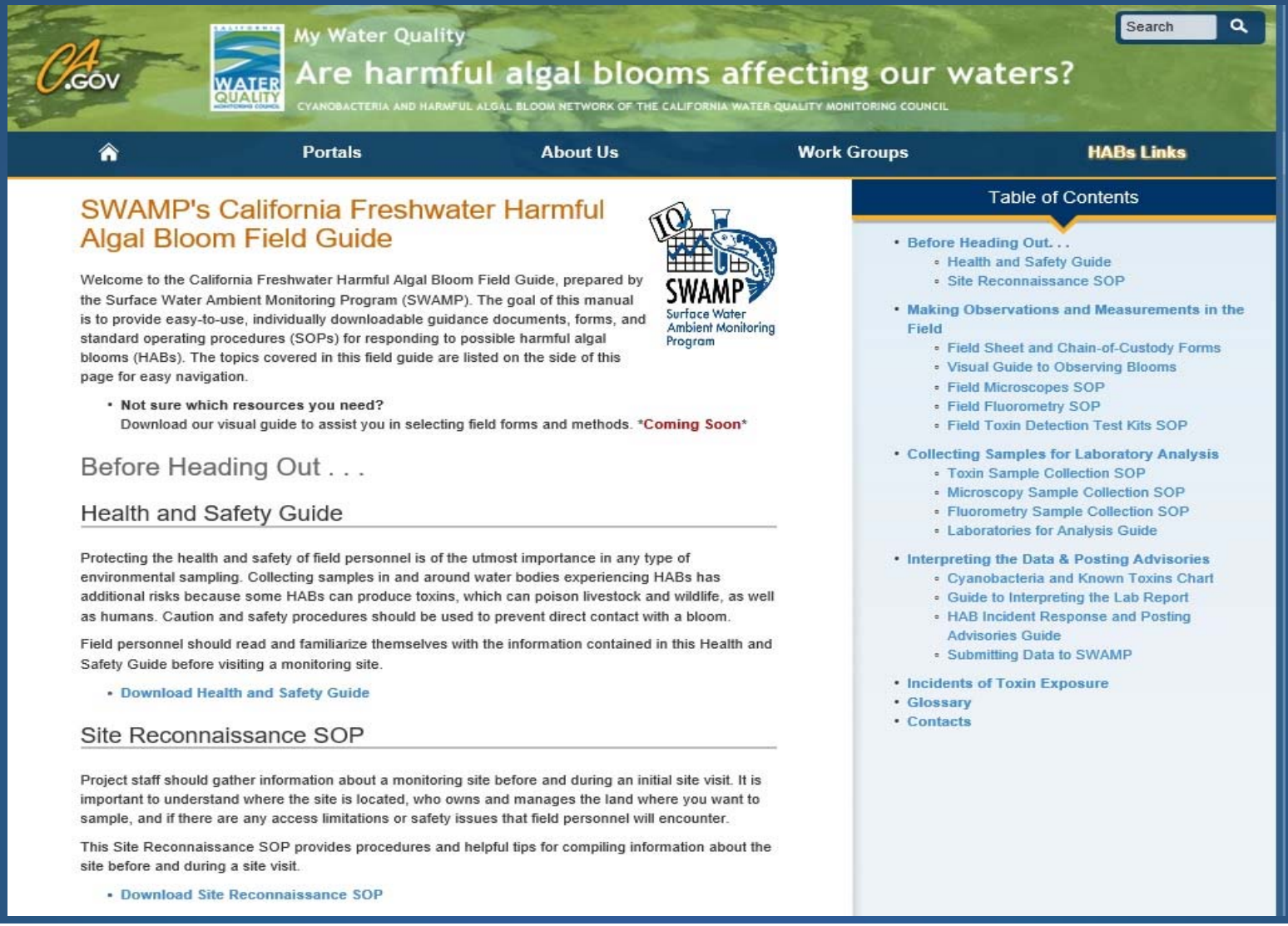
Statewide Guidance for Fresh Water Harmful Algal Blooms in Recreational Waters

http://www.mywaterquality.ca.gov/habs/resources/index.html#recreational

California Strategy

Standard Operating Procedures for Monitoring & Sampling

http://www.mywaterquality.ca.gov/habs/resources/field.html



California Strategy

Standard Operating Procedures for Monitoring & Sampling

Cyanoscope

Test Strips

Field Sampling Kits

FluoroSense™ Handheld Fluorometer

California Strategy

Laboratory Resources

http://www.mywaterquality.ca.gov/habs/resources/index.html#laboratory

CyanoHABs Laboratory List

The purpose of this laboratory list is to readily provide information about laboratories capable of analyzing water samples for cyanobacteria and the toxins cyanobacteria can produce. This list is not intended to describe any regulatory requirements or make any laboratory endorsements. The laboratories are listed in alphabetic order. Please note – laboratories should be contacted prior to submitting any samples. Many laboratories discussed flexibility in prices and the need to coordinate any sampling and analysis. {This list was last updated September 2016}

Cyanotoxin Analysis								
Laboratory	Matrix	Cyanotoxin	Method	MDL (µg/L)	RL (µg/L)	Response Time	Sample Storage/ Shipping Condition	Shipping Preference
Beagle Bioproducts Inc. Contact: (614) 682-6588 info@beaglebioproducts.com Location: Columbus, OH	DW, AW	microcystins, total	ELISA	contact lab	contact lab	2 day response time. 24 hours response time upon request and additional fees.	Go to Beaglebioproduct.com for sampling kits & shipping containers for purchase. Go to beaglebioproducts.com for sampling guide and more details.	Fedex overnight. Samples collected over weekend should be frozen and shipped Monday.
	DW, AW	microcystins	LC-MS	contact lab	contact lab			
	DW, AW	microcystins	LC-MSMS	contact lab	contact lab			
	DW, AW	anatoxin-a	ELISA	contact lab	contact lab			
	DW, AW	cylindrospermopsin	ELISA	contact lab	contact lab			
	DW, AW	saxitoxins	ELISA	contact lab	contact lab			
	DW, AW	anatoxin-a	LC-MS	contact lab	contact lab			
	DW, AW	cylindrospermopsin	LC-MS	contact lab	contact lab			
	DW, AW	saxitoxins	LC-MS	contact lab	contact lab			
BEND GENETICS, LLC LABORATORY Contact:(541) 600-GENE or customer_service@bendgenetics.com Location: Sacramento, CA	DW, AW	microcystins, total	ELISA	0.10	contact lab	Response time next day from sample receipt (Mon. – Thurs. delivery), and rush services (same day) can be arranged.	Frozen or on wet ice	No preference
	DW, AW	anatoxin-a	ELISA	0.10	contact lab			
	DW, AW	cylindrospermopsin	ELISA	0.04	contact lab			
	DW, AW	saxitoxins	ELISA	0.015	contact lab			
	DW, AW	domoic acid	ELISA	6	contact lab			
	Tissue (shellfish)	microcystins	ELISA	contact lab	contact lab			
	Tissue (shellfish)	saxitoxins	ELISA	0.015	contact lab			
	Tissue (shellfish)	domoic acid	ELISA	30	contact lab			
	Tissue (shellfish)	okadaic acid	ELISA	100	contact lab			
CA Animal Health and Food Safety Lab (CAHFS), UC Davis Contact: (530) 752-7578 Location: Davis, CA	Note: Lab analyzes samples related to *animal health*. The lab can analyze animal samples (tissues and stomach contents) related to possible animal exposures to cyanotoxins from harmful algal blooms.			contact lab	contact lab	contact lab	contact lab	No preference

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Education and Outreach

http://www.mywaterquality.ca.gov/habs/resources/index.html#informational

Informational Presentations

- 2016 One Day Workshop on **Identifying and Responding to Cyanobacteria Harmful Algae Waterblooms in California** - Recorded June 14, 2016 at the University of California, Davis
  These lectures, organized by the State Water Resources Control Board's Training Academy and OIMA's Surface Water Ambient Monitoring Program (SWAMP) in cooperation with UC Davis Extension, were recorded and can be viewed on YouTube.
  - HABs Workshop Video Playlist
  - Introduction: Goals of Workshop 9:35
  - Lecture 1: History and Biology of Harmful Algae Blooms (HABs) National and International Approaches to Detection, Management and Mitigation 56:18
  - Lecture 2: Sampling, Handling, Storage and Shipment of CyanoHABs 46:09
    Includes guidance on their classification as hazardous substances.
  - Lecture 3: Cyanobacteria taxonomy, identification, enumeration and biovolume determination 1:07:16
  - Lecture 4: SWAMP Freshwater HABS Program and Resources & CCHAB Voluntary Guidance Updates 52:47
  - Lecture 5: Management and mitigation options, a ground level approach 46:20
  - Lecture 6: Lab – Identification of CyanoHABs-discussion of taxonomy keys plus some discussion/demonstration of sampling, handling and enumeration 23:15
  - 2015 Lecture: An Introduction to Using Dichotomous Keys to Identify Organisms Causing Harmful Algal Blooms (HABs) 5:08
- California Water Quality Monitoring Collaboration Network's Cyanobacteria (Blue-green algae), January 2016
  - Widespread Prevalence of Cyanobacteria & Cyanotoxins from a Variety of California Waterbodies 1:09:28
  - The California CyanoHAB Network (CCHAB) 42:21
  - Genetic Testing of Cyanobacteria Blooms 49:27
  - Biotoxin Gene qPCR Assay for the Aquatic Motoring and Management of Biotoxin Risk 49:58
- Other Presentations
  - CyanoHABs Field Testing Presentation - May 31, 2016
  - Western Regional Epidemiology Network - May 21, 2015
  - Monitoring and Assessment Partnership Webinar - May 19, 2015

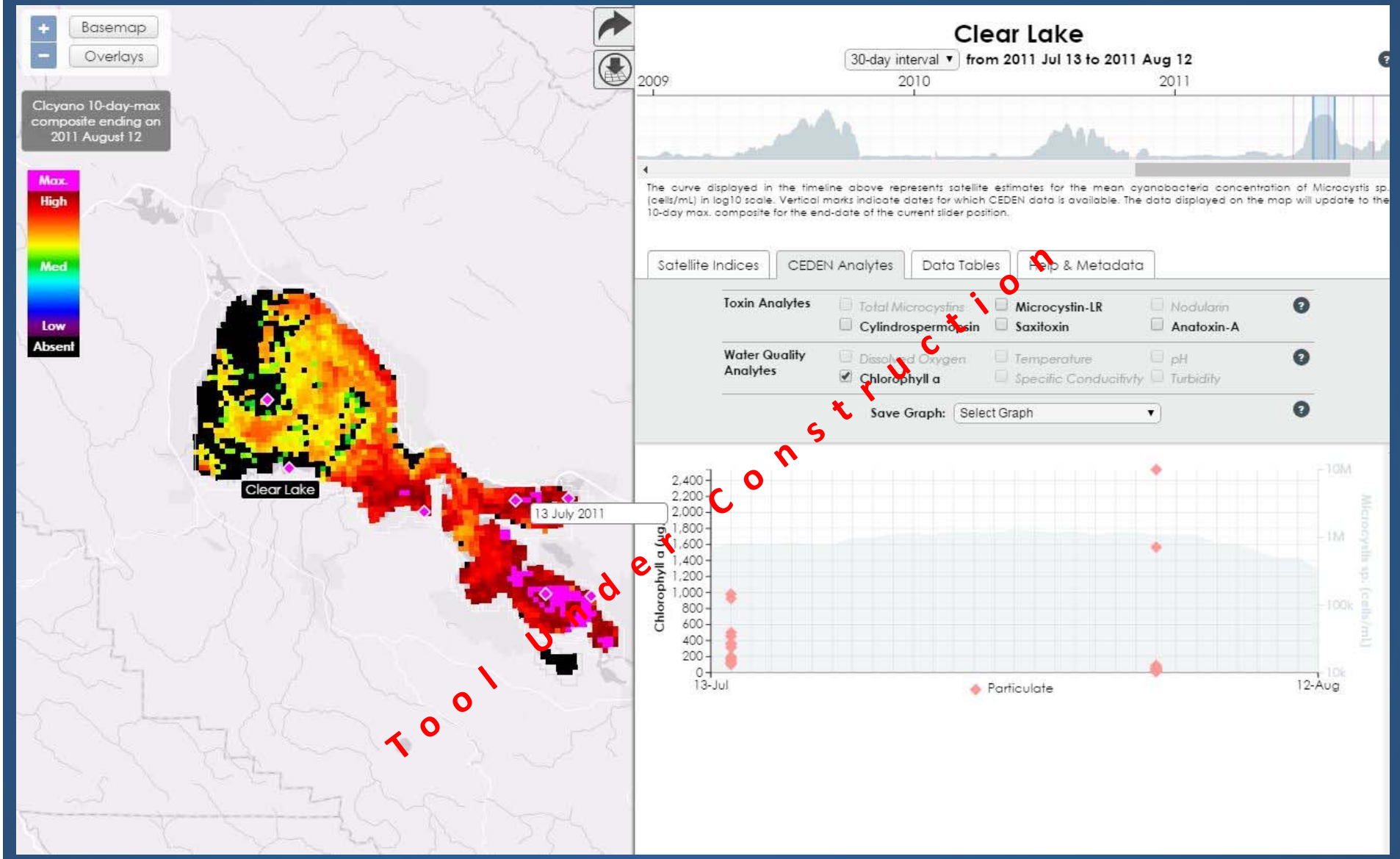
SWAMP Surface Water Ambient Monitoring Program

CALIFORNIA WATER QUALITY MONITORING COUNCIL

California Strategy

Satellite Imagery for Early Bloom Detection

http://www.mywaterquality.ca.gov/habs/where/satellite.html



California Strategy

Building Partnerships

http://mywaterquality.ca.gov/monitoring_council/cyanohab_network/index.html

- CA Cyanobacteria and Harmful Algal Bloom Network (CCHAB)
- Partnership of state, federal, and local agencies, tribes, and non-governmental organizations

- Under the overarching guidance of the California Water Quality Monitoring Council

Lessons Learned

- Prepare for response BEFORE it is necessary
  - lab analysis
  - standard operating procedures
  - responders contact list
- Press releases and talking points important
- More outreach needed
  - public education & “healthy habits”
  - treatment methods & toxin release
  - State legislature & state, county, city agencies

Lessons Learned

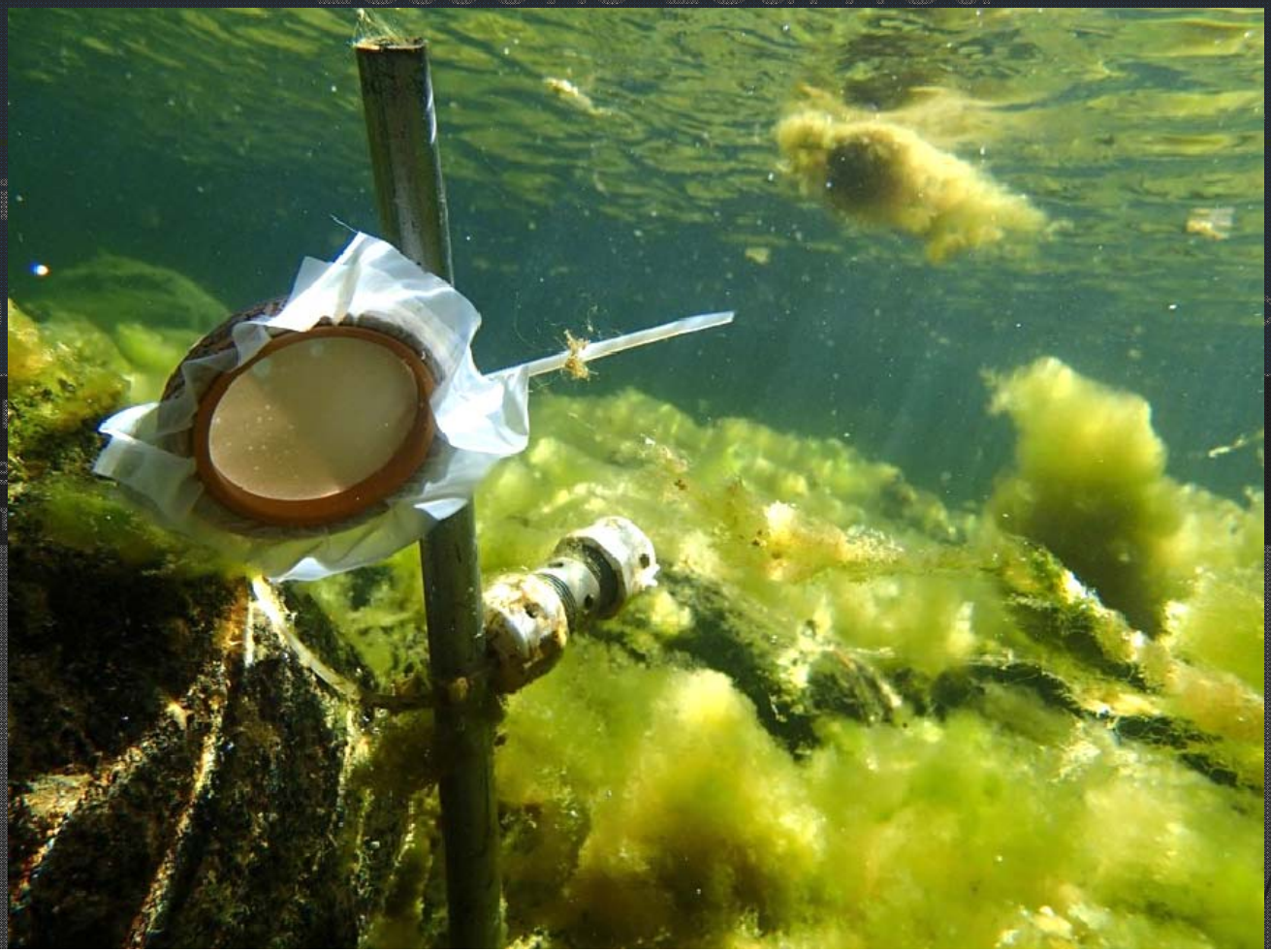
Must Recognize Impact of Benthic River Blooms

- Toxins present during entire sampling period (June – October)
- 3 sample methods = 3 different pictures of toxin conditions

Russian River Samples collected 9/11/16 (SPATT 8/29/16 - 9/11/16)	Microcystin (liver toxin)	Anatoxin (neurotoxin)
SPATT	3.474 ng toxin / g resin	ND
Water Grab	ND	ND
Algae Grab	0.45 ug/L	>15,750 ug/L

- High concentrations of anatoxin in algae, non-detects in water
- Low concentrations of microcystin
- Low level of planktonic cyanobacteria

Lessons Learned



Solid Phase Adsorption Toxin Tracking (SPATT)

Lessons Learned

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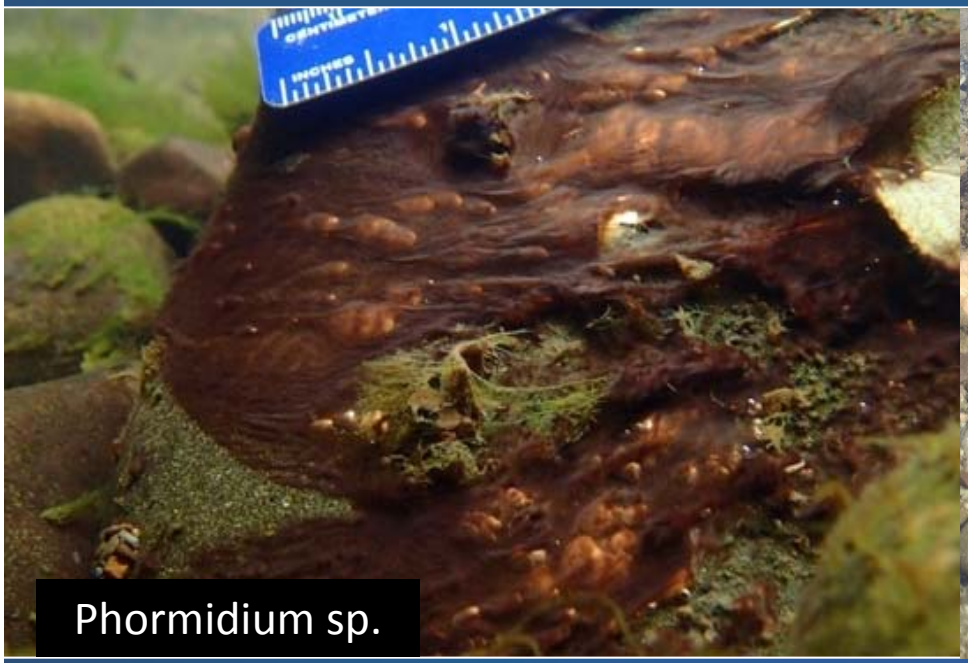
Lessons Learned

Must Recognize Impact of Benthic River Blooms

- Some cyanobacteria prefer fast flowing water
- Anatoxin appears to be toxin of highest concern
- Method of laboratory analysis is important (ELISA vs LCMS)
- SPATT deployment time matters

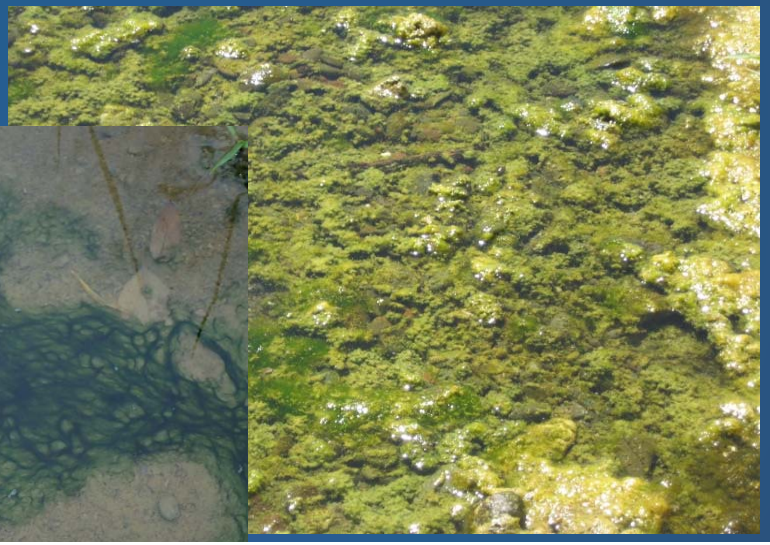


Phormidium sp.

Oscillatoria sp.

Remaining Challenges

- Lack of legislative mandate = lack of staff, funding, & authority
- Building monitoring & response partnerships takes time
- Monitoring & lab analysis is expensive
- Need to address bloom "risk factors"
- Benthic river blooms pose a new/ different challenge



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Clear Lake

Photo Credit: Karola Kennedy

Russian River

Photo Credit: Rich Fadness